ECE 465, Spring 2005, Instructor: Prof. Shantanu Dutt

Midterm: Thurs, March 17, Time: 4-5:15pm
Exam Format: Closed Book and Notes, Total Points: 100

Important Note: You need to show all your work **clearly** in deriving the answers. Just writing down the final answers is not enough.

Suggestion: Begin by reading all questions and do those first that you think you know best.

1. For the following three functions:

   $f_\alpha(A,B,C,D,E) = \sum m(0,1,3,4,5,7,13,15,21,23,25,27)$

   $f_\beta(A,B,C,D,E) = \sum m(0,4,21,23,25,27,28,29,30,31)$

   $f_\gamma(A,B,C,D,E) = \sum m(0,1,3,4,25,27,29,31)$

   the PI formation phase of multi-function QM yields the following PIs:

   $PI_1^\alpha = \sum m(5,7,13,15)$

   $PI_2^\alpha = \sum m(5,7,21,23)$

   $PI_3^\alpha = \sum m(1,3,5,7)$

   $PI_4^\alpha = \sum m(0,1,4,5)$

   $PI_5^{\alpha,\gamma} = \sum m(1,3)$

   $PI_6^{\alpha,\beta,\gamma} = \sum m(0,4)$

   $PI_7^{\alpha,\gamma} = \sum m(0,1)$

   $PI_8^{\alpha,\beta} = \sum m(21,23)$

   $PI_9^{\beta} = \sum m(21,23,29,31)$

   $PI_{10}^{\beta} = \sum m(28,29,30,31)$

   $PI_{11}^{\beta,\gamma} = \sum m(25,27,29,31)$

   $PI_{12}^{\alpha,\beta,\gamma} = \sum m(25,27)$

   Obtain the SOP expressions for the 3 functions using: (i) the PI-table part of multi-function QM, followed by (ii) the sweep-up phase, so that the **total** cost over all the three functions is minimized.

   Do the PI-table part in the provided PIT, write your name on it and submit inside your answer sheet.

   Show the expressions **before** and **after** the sweep-up phase, give the total cost **before** and **after** the sweep-up phase, and circle the shared PIs in the final expressions, i.e., after the sweep-up phase. **50**

Important Note:

Remember to do the following in the PIT part to avoid getting points taken off:

(a) Show row and column coverings by appropriate arrows.

(b) Number the row and column deletions in order.

(c) When starring a PI (when it becomes essential or pseudo-essential), by the star-mark note the function flags in whose expressions it will be included (these are functions whose undeleted MTs it covers at the current point, i.e., point of starring).

(d) Also, when starring a PI, put a tick-mark in the tick mark column for this PI, and by the tick mark note the function flags for which it is essential at the current point (i.e., those functions whose undeleted **singleton** MTs/cols it covers at the current point). These flags will be either the same as or a subset of the flags by the star mark of the PI.

Remember to do the following **after** the PIT part:

At the end of the PIT part, a starred PI is included in a function if it has a flag corresponding to the function by its star-mark. This PI is also tick marked only in those functions whose flags appear by the tick-mark of these PIs.

In the sweep-up phase, for each function f, a **non-tick-marked** PI of f can be deleted from f's expression if each of its MTs is covered by some **tick-marked** PI of f.

2. Design a 16:1 Mux using the following components: **four** 4:1 Muxes and **three** 2:1 Muxes using a similar divide-&-conquer strategy used for designing a $2^n : 1$ Mux using only 2:1 Muxes.

   Label the data inputs and select inputs appropriately. Note that if the data inputs are labeled in order from I_0 to I_{15}, then the initial level Muxes in the D&C design will be controlled by the lesser significant bit(s) of the control inputs and the later-level Muxes will be controlled by the higher significant bit(s) of the control inputs. Assume that the control inputs are A, B, C, D with A the MSB and D the LSB. **30**

   Hint: You could break up the design into only 2:1 Muxes to start with, then determine which groups of 2:1 Muxes in two adjacent levels form 4:1 Muxes and substitute the four 4:1 Muxes available for four such groups of 2:1 Muxes.

3. Answer the following questions clearly with precise and complete explanation/rationale. Provide examples where necessary to better illustrate your explanation.

   For Petrick's algorithm:

   (i) What is the OR term for a MT/column of the PI table; give an example. **3**

   (ii) What is the meaning attached to each PI in such an OR term? Is each PI an actual PI of the original function f we are minimizing or is it a variable representing the corresponding PI? In the OR term, what does it mean if the value of a "PI-variable" is a 0 and what does it mean if it is 1? **7**

   (iii) With the above interpretation of the meaning of a PI-variable, is it correct to say that if the product of the OR terms of the MTs of the PI table is 1, then it means that all MTs are covered? Why or why not, and if this is true, which PIs are all the MTs covered by? Note that we are not talking about ANDing out the product of OR terms to get an SOP expression; the questions pertain to the initial expression which is the the product of the OR terms of the MTs. **10**